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Surgical Techniques for Arthrodesis of Two to Four Adjacent Spinal Vertebrae Throughout the Entire Spinal Column

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Surgical Techniques for Arthrodesis of Two to Four Adjacent Spinal Vertebrae Throughout the Entire Spinal Column

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Surgical techniques for cervical, thoracic and lumbar spinal fusions have been described. So far, 51 such fusions have been performed with satisfactory results.

Spinal fusion can be defined as a surgical procedure by which a surgeon attempts to produce synostosis of two or more adjacent spinal vertebrae. Generally, its three main objectives are:

1. To provide stability of the spine.
2. To correct or prevent deformity of the spine.
3. To relieve pain and suffering from diseases of the spine.

Based on clinical experience, diseases and deformities which may require spinal fusion include the following:

1. Trauma — fractures and dislocations.
2. Congenital anomalies — hemivertebra, scoliosis, spondylolisthesis, etc.
3. Degenerative diseases — osteoarthritis, ruptured disks, etc.
4. Inflammatory diseases — rheumatoid arthritis, ankylosing spondylitis, etc.
5. Infections — caused by bacteria, fungi, parasites, etc.
6. Tumors — benign, malignant or metastatic tumors that cause significant destruction of the spine.
7. Metabolic bone diseases and osteoporosis, osteomalacia, etc.
8. Endocrine disorders — hyperparathyroidism, hyperthyroidism, hyperpituitarism, etc.
9. Diseases of skeletal muscle — different myopathies, neuromyopathies, etc.
10. Hereditary diseases — Marfan's syndrome, osteogenesis imperfecta, Ehlers-Danlos syndrome, etc.
11. Diseases of the nervous system — poliomyelitis, cerebral palsy, meningomyelocele, etc.

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This is the first in a series of papers by Dr. Wu which will describe techniques and experience at Henry Ford Hospital

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From an anatomical point of view, five different surfaces are available for spinal fusion on each vertebra. They include the vertebral body, the two transverse processes, the two superior and inferior articular processes, the two laminae and the spinous process. However, because the anterior surface of the transverse processes and the vertebral body are situated in the anterior aspect of the vertebral column, it naturally follows that there are two general approaches to the spine, namely, the anterior and the posterior approaches.

In surgical operations, either an anterior or posterior spinal fusion can be done. The anterior approach is used to gain access to the anterior surface of the transverse process and the vertebral bodies. The posterior approach enables the surgeon to expose the posterior surface of the transverse processes, the articular processes, the laminae and the spinous processes. The anterior spinal fusion is commonly called an interbody fusion. Posterior spinal fusions can be posteromedial or posterolateral. The posteromedial fusion usually includes the spinous processes, the laminae and the articular processes. The posterolateral fusion normally incorporates only the transverse processes and the articular processes. Due to the numerous indications for spinal fusion, many surgical techniques and their results have been published in the medical literature.[1-116]

The surgical techniques described in this paper are the ones we routinely use.

Techniques

The "H" graft technique for C1-C2 fusion (Figures 1-2)

An incision about 4" in length is made along the midline of the posterior aspect of the neck extending from the external occipital protuberance to the spinous process of C3. The cervical paraspinal muscles are stripped from the posterior arch of atlas and the spinous process and laminae of axis.

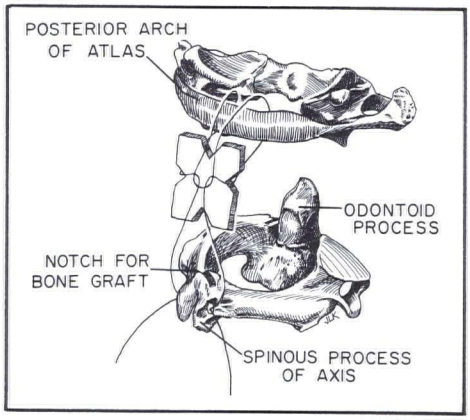

Figure 1
The stainless steel wire has been passed around the iliac graft and the posterior elements of C1 and C2 vertebrae prior to its tightening.

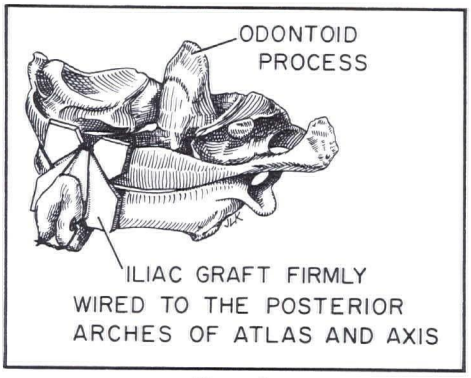

Figure 2
The stainless steel wire has been tightened and the iliac graft is now firmly wired to the posterior arches of atlas and axis.

These exposed bone surfaces are roughened with a sharp bone rasp. Next, a notch about ¼" in depth is made at the superior base of C2 spinous process with a small rongeurs and a small hole is also made through the same spinous process slightly above the notch with a sharp right-angled awl. Using a small rongeurs, four notches are cut in the four sides of the rectangular iliac graft with the top and bottom notches along the midline and the two lateral notches more proximally based. A size 20 stainless steel wire loop is passed upward under the posterior arch of atlas and the sculptured iliac graft is placed on the posterior arch of atlas, care

being taken to firmly engage the inferior notch of the graft with the superior notch of C2 spinous process. The two ends of the wire are made to engage the two lateral notches of the iliac graft and are passed through the wire loop. Tension is applied to the two ends of the wire simultaneously. As the slack is taken out, the iliac graft is forced to make intimate contact with the posterior arch of atlas. The two ends of the wire are passed under tension through the hole at the base of C2 spinous process in opposite directions. They are then turned downward and are tightly twisted together against the inferior base of C2 spinous process. The incision is closed in the usual manner.

The dual onlay iliac graft technique for fusing two to four spinal vertebrae from C-2 to T-12 (Figures 3-7)

After skin incision and stripping of paraspinal muscles at the appropriate spinal level, an air-powered bur is used to decorticate partially the spinous processes, the laminae and the posterior aspect of the adjacent articular processes. Small holes are made through the bases of the spinous processes with a sharp right-angled awl. Two pieces of mirror-image iliac grafts are obtained from the outer table of ilium. Holes matching the holes of the spinous processes in size and distance are drilled through the iliac grafts with a small bur. With size 20 stainless steel wire, the two grafts are tightly wired to the decorticated spinous processes and the laminae of the spinal segments to be fused. Match-stick iliac grafts are placed over the decorticated articular processes. The incision is closed in the regular manner.

Although the dual onlay iliac graft technique can be used in lumbar spinal fusion, our experience shows that very large pieces of iliac bone are required to accomplish the fusion due to the relatively large dimensions of the lumbar vertebrae. Consequently, we prefer the spinous process splitting technique for our lumbar spinal fusion.

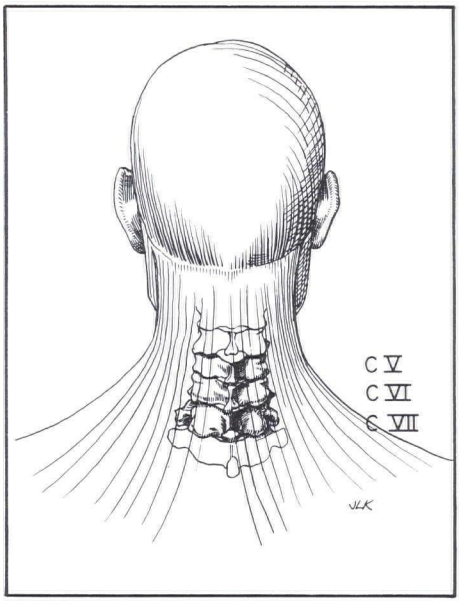

Figure 3
A transparent view of the posterior aspect of C5, C6 and C7 vertebrae.

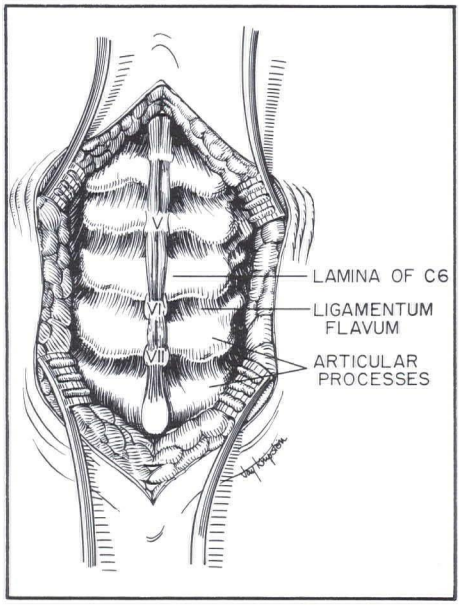

Figure 4
The cervical paraspinal muscles have been stripped from the posterior arches of C5, C6 and C7 vertebrae.

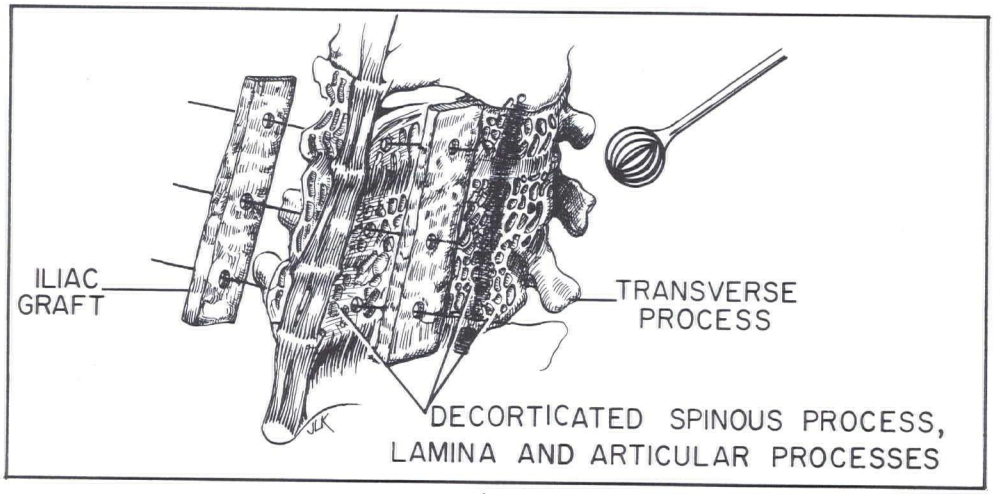

Figure 5
The dual iliac grafts are about to be wired to the decorticated spinous process and laminae.

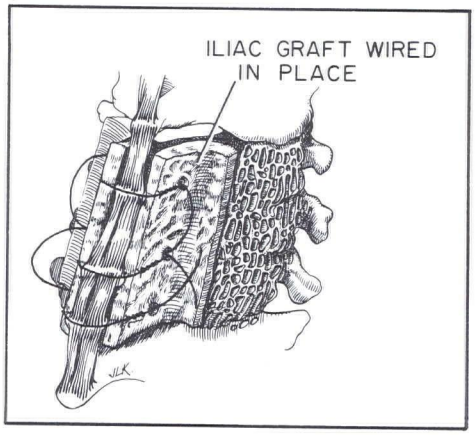

Figure 6
The dual iliac grafts have been firmly wired in place.

The spinous process splitting technique for lumbar spinal fusion (Figures 8-13)

After the skin incision and stripping of lumbar paraspinal muscles have been accomplished, the basal portions of the spinous processes, the laminae and the articular processes are decorticated with a sharp spinal gouge. The supraspinous ligaments, the interspinous ligaments and the spinous processes of the vertebra to be fused are split down the midline almost to the neural arches with a stryker saw and a wide osteotome. A properly prepared iliac graft is forcefully inserted into the split space bridging the spinous processes together. Holes are made through the bases of the spinous processes and size 20 stainless steel wires are used to hold the iliac graft tightly between the split spinous processes. Match-stick iliac grafts are placed over the decorticated spinous processes, laminae and articular processes. The incision is closed in the usual manner. Somtimes a lumbar spinal fusion is needed following a wide posterior decompression lumbar laminectomy which usually removes the spinous processes, the laminae and parts of the articular processes. In these circumstances, the surgeon can perform a posterolateral fusion which can be accomplished by partially decorticating the adjacent articular processes and the transverse processes with an air-powered bur. This is followed by placing long and slender iliac grafts in the gutter formed by the articular processes and the transverse processes of the involved vertebrae (Figures 14-15).

Postoperative managements

The cervical fusion is usually protected with a plaster minerva cast for about three months followed by the use of a four poster cervical brace or a cervical collar for an additional two to three months.

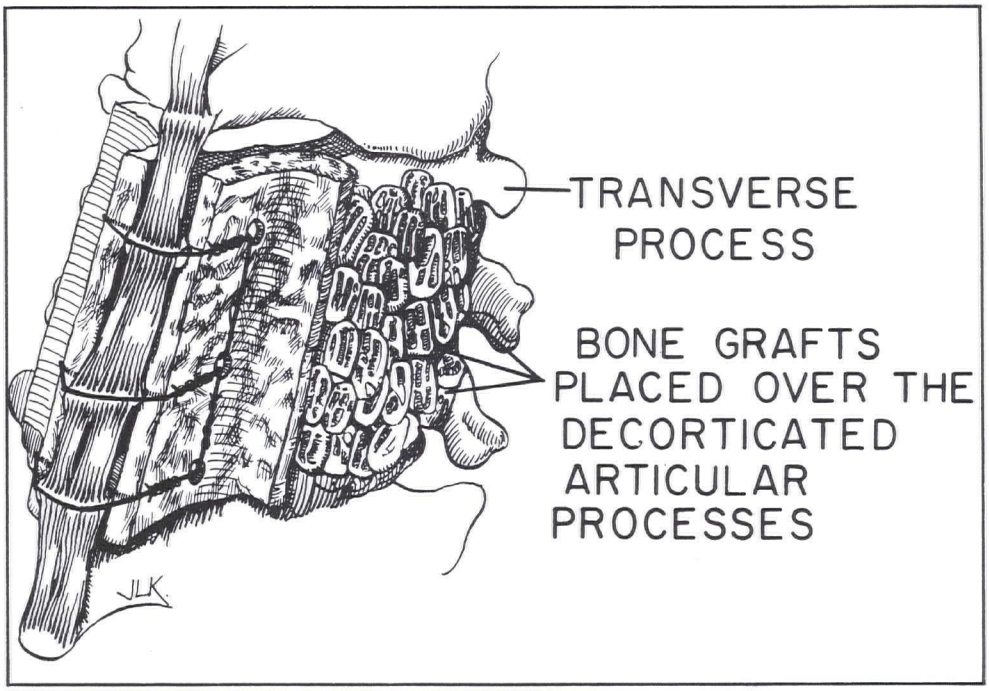

Figure 7
The iliac bone chips have been placed over the decorticated articular processes.

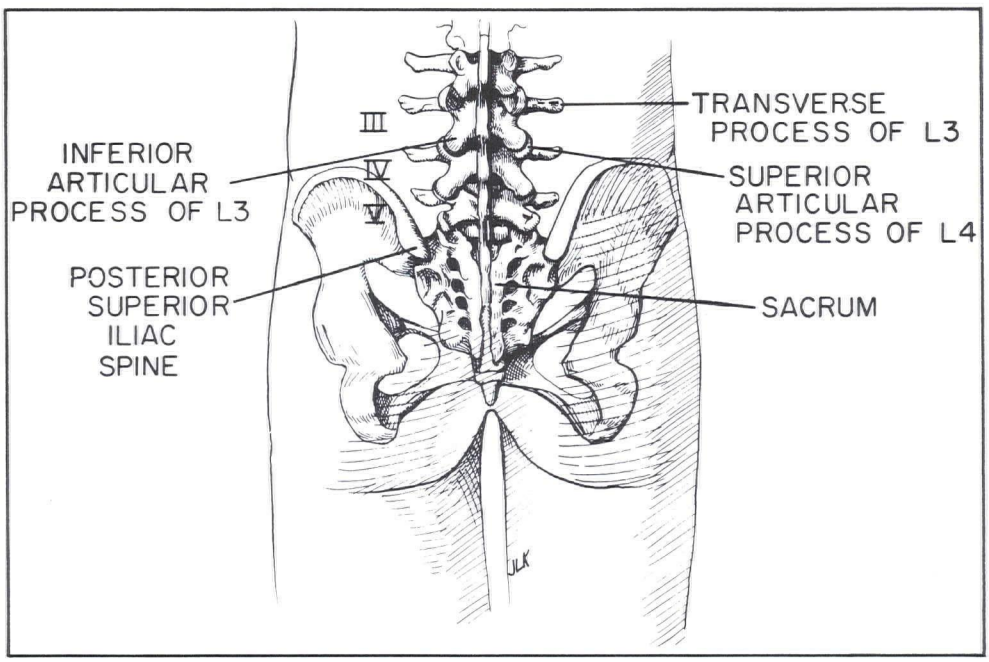

Figure 8
A transparent view of the posterior aspect of the lumbosacral spine.

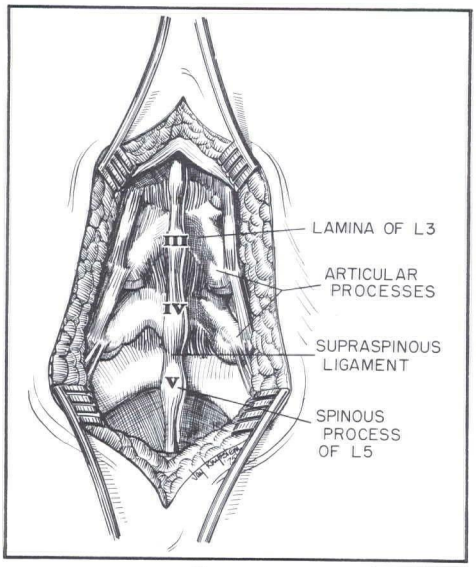

Figure 9
The lumbar paraspinal muscles have been stripped from the posterior arches of L3, L4 and L5 vertebrae.

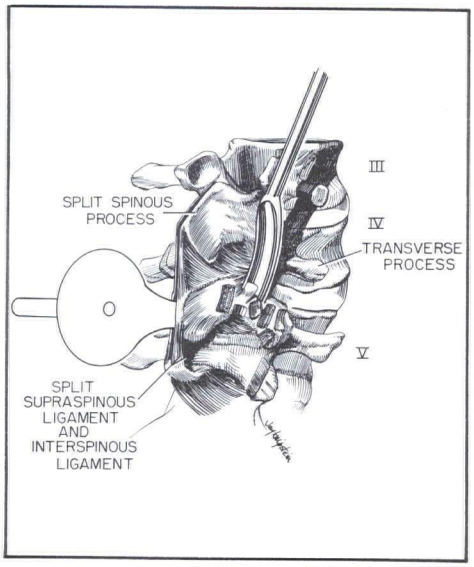

Figure 10
The spinous processes are being split with a stryker saw and the posterior arches are being decorticated with a spinal gouge.

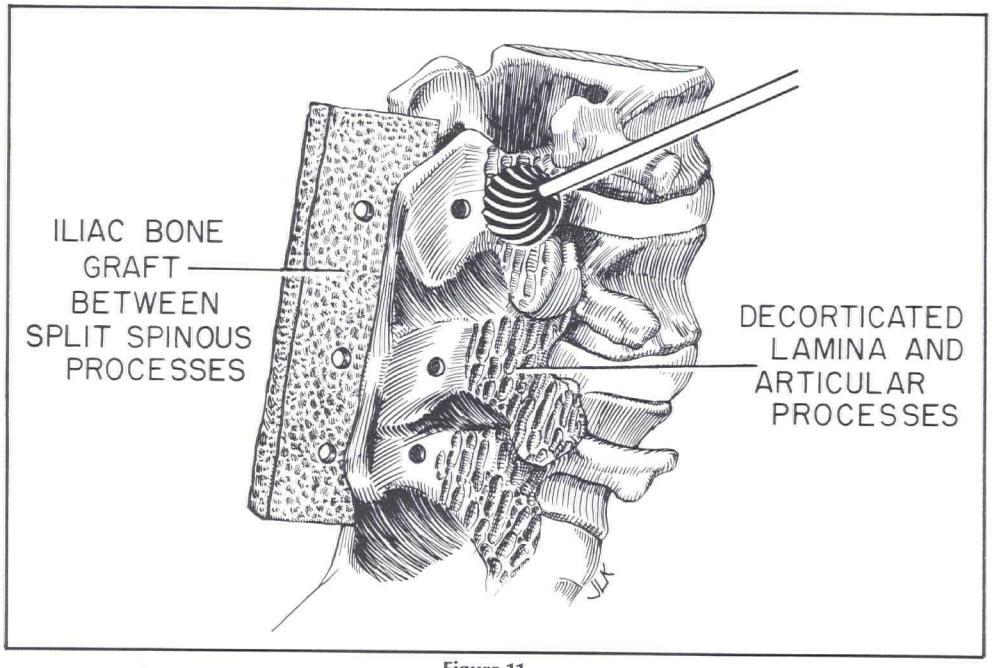

Figure 11
The iliac graft is being inserted into the split spinous processes and the laminae and the articular processes can also be decorticated with an air-powered burr.

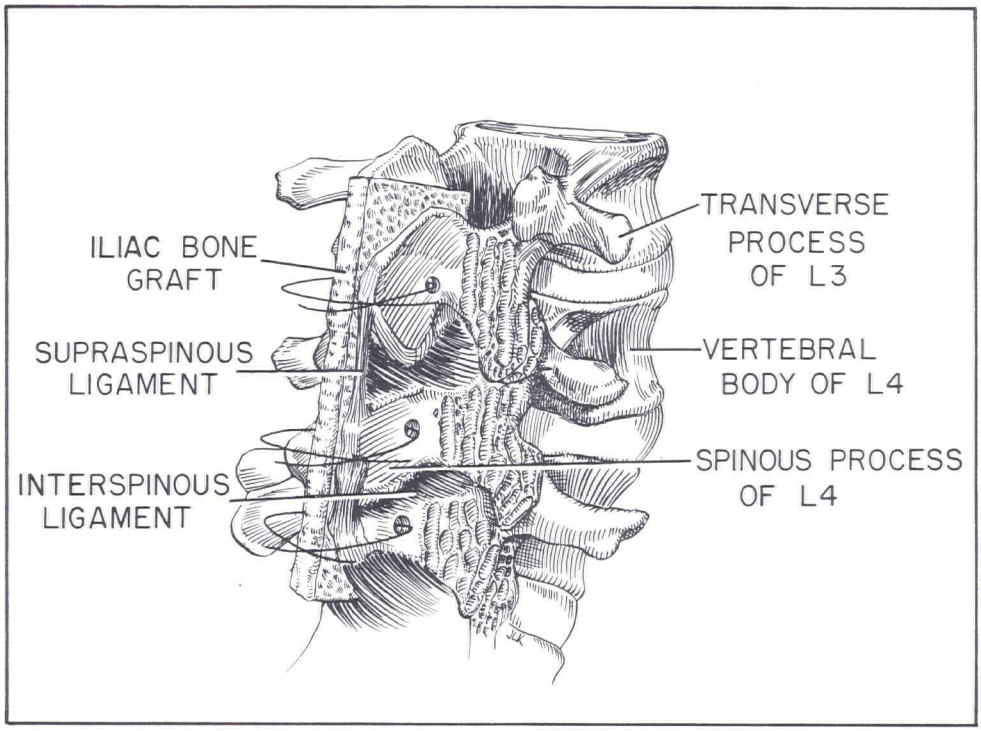

Figure 12
The iliac graft is being wired to the split spinous processes.

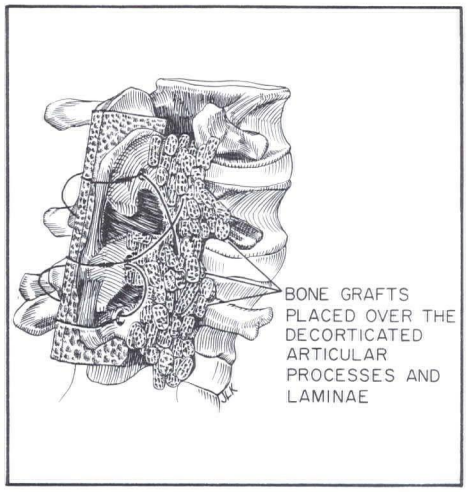

Figure 13
Iliac bone chips have been placed over the decorticated laminae and articular processes.

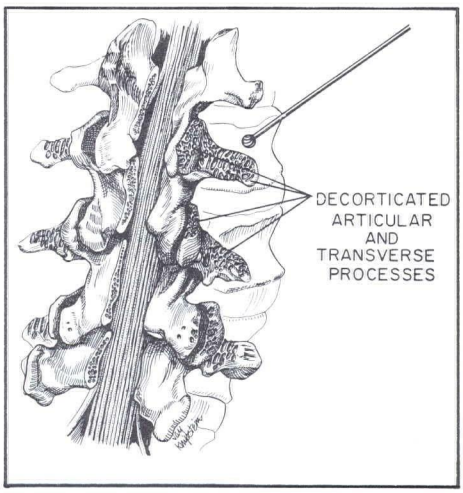

Figure 14
The articular processes and the transverse processes are being decorticated with an air-powered burr.

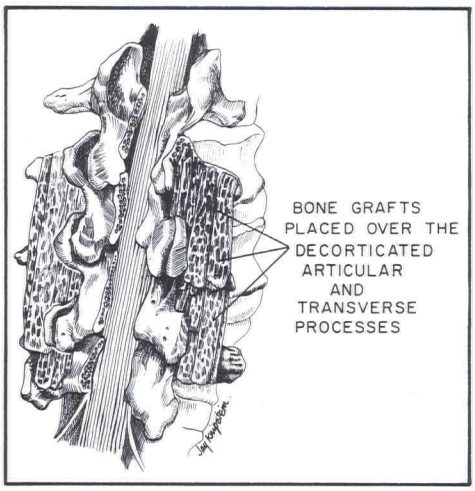

Figure 15
Long and slender iliac bone grafts have been placed in the gutter formed by the decorticated articular processes and the transverse processes.

Thoracic and lumbar fusions are managed in a plaster body cast for about three months. Then a back brace is worn for an additional two to three months.

About 24 hours after the cast is applied, the patient is urged to get up and ambulate for the purpose of preventing postoperative pulmonary, vascular, urinary and skin complications. After discharge from the hospital, patients are seen on an outpatient basis at monthly intervals. They are also encouraged to pursue light daily activities.

Discussion

Our spinal fusion techniques have been utilized in 51 spinal fusions. They include three C1-C2 fusions, three lower cervical fusions, three thoracic fusions and 42 lumbar and lumbosacral fusions. So far, our results have been exceptionally good. A detailed analysis of all our spinal fusion cases will be published when a much bigger series has been accumulated.

Summary

Surgical techniques for fusing two to four spinal segments throughout the entire spinal column have been described. So far, 51 such fusions have been performed with very encouraging results.

Acknowledgement

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